Final UREAP Report

Increasing Cognitive Load to Examine the Modulating Effects of Cognitive Function and Anxiety on Performance

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Summary

For my summer Undergraduate Research Experience Award Program (UREAP), my research was focused on studying the effects of cognitive load on the relationship between anxiety and cognitive function, particularly working memory. I focused on creating a literature review that allowed me to gain background knowledge on working memory, anxiety, and the deleterious effects on cognitive performance, specifically in older adults. With this literature review, I was able to investigate existing cognitive tasks and methods used by other researchers, which allowed me to better understand the most effective way to increase an individual's cognitive load while at the same time measuring its effects on cognitive performance and relating these effects to high or low anxiety. The idea is that anxiety intervenes with cognitive performance of a task but only in tasks that are complex, that have increased cognitive load. Though the original research design entailed testing individuals in the lab, my supervisor and I adapted the experiment to a web-based platform to design the study. Thus, the early stages of research required exploring which online platform was best suited to create the experiment. Through exploration, the platform that was decided on was Gorilla, a simple, user-friendly experiment builder program that is widely used and focuses on providing instructional videos on designing questionnaires, spreadsheets, and tasks to undergraduate and graduate students for their research. After spending time learning how to use the Gorilla platform, I created multiple questionnaires measuring mood and anxiety as well as several cognitive tasks that measure working memory and in which cognitive load can be increased. The UREAP program allowed me to secure an honours position for the fall and winter in which I intend to collect data using these tasks and questionnaires.

Background

The reason I chose to investigate cognitive decline and anxiety is that past researchers have thoroughly studied this relationship, all coming to varying conclusions regarding the nature of the connection between cognitive function (working memory and attention) and anxiety; though, few researchers have fully exhausted the potential for investigating this relationship using older adults.

Anxiety is among the most prevalent mental health disorder, which adversely impacts our cognitive functions, mainly working memory and attention, which are needed to carry out everyday activities. Research has long discovered that working memory (WM) is crucial for normal functioning since it helps to control our attention, as well as temporary store and process information needed, for example, to carry on a conversation or remember or write down a phone number (Vytal, Cornwell, Letkiewicz, Arkin, & Grillon, 2013). Anxiety hinders our ability to perform goal-directed tasks by restricting our working memory capacity due to enhanced competition of neural resources, leading to a decrease in cognitive performance, such as reading comprehension, problem-solving, and standardized intelligence tests (Moran, 2016).

Differences in task performance are further observed when cognitive load (CL) is increased (Paas, Tuovinen, Tabbers, & Van Gerven, 2003). CL is described as the number of processing resources required to complete a given task (Paas et al., 2003). Researchers, such as Berggren and colleagues (2013), suggest that increasing the CL in tasks disrupts the attentional control processes in individuals with higher trait anxiety levels. Thus, higher cognitive load results in a diminished ability to maintain task goals when attentional control is already reduced by heightened anxiety levels, leading to an overall breakdown in performance ability and processing speed (Berggren, Richards, Taylor, & Derakshan, 2013).

As previously discussed, much of the current research has focused on the interactions between anxiety and cognitive function in younger adults, with findings indicating that higher anxiety correlates with lower working memory capacity (for review, see Moran, 2016). However, research involving the influence of anxiety on older adults' cognitive performance, a population that notably experiences a cognitive decline, has been limited. Recent study findings by Mella and colleagues (2018) proposed that older adults are more vulnerable to anxiety's unfavorable effects on their cognitive performance involving attention and working memory. Mella et al. (2018) concluded that older adults with lower working memory capacity seem to exhibit higher anxiety and show poorer performance (Mella et al., 2018). Thus, the scarce research in this field only emphasizes the importance of understanding the interactions between anxiety and cognitive function and recognizing what forms of anxiety influence working memory and attention apart from the age-related cognitive decline that might also be present during cognitive assessments.

Aims

The goals of my research were to create an extensive literature review detailing the relationship between age-related cognitive decline and anxiety; specifically, by investigating whether older adults with a cognitive decline also experience high levels of anxiety and if working memory capacity acts as a modulator of performance when cognitive load is increased. With this review, I learned effective ways of reading and summarizing peer-reviewed research articles that overall help me build a strong background of knowledge. The primary focus was to research existing cognitive tasks that have proved successful in increasing an individual's cognitive load and measuring their working memory capacity. With this literature review, I discovered the most appropriate task for my design that would also be easily adapted to an online

testing format. Another main objective of my research was to find a suitable online experiment builder platform where I could develop my design and collect data remotely. Throughout the summer, I learned how to use one platform in particular called Gorilla (https://gorilla.sc/), on this site, I learned how to develop consent forms, demographic and anxiety-related questionnaires, and code complex and simple tasks using spreadsheets and scripts. I collaborated with my supervisor and exchanged comments and ideas regarding the design, which led to learning valuable skills in communicate complex information online. I was heavily involved in the design of the tasks. This will prove advantageous given the current situation. Another important objective of my research was to understand how to ensure data quality, especially using an online platform to recruit and test participants. This is because there are increased risks of participants cheating and losing focus during an online experiment. Therefore a few ways to improve data quality was to increase the exclusion criteria, record reaction times, and use attention/ instruction checks.

Methodology

After conducting and writing a thorough literature review to investigate previously used tasks and methods involving cognitive function and anxiety, I selected and designed a series of cognitive tasks that I would implement in my own study. For several weeks, I learned how to navigate and troubleshoot Gorilla effectively; thus, after becoming proficient on the platform, I began creating questionnaires. The questionnaire first created was a demographic questionnaire containing general information and health-related questions, and exclusion criteria. I then used the Depression Anxiety Stress Scale (DASS) to form the second questionnaire, using only the mood questions. The last questionnaire used was the State-Trait-Anxiety Inventory (STAI), broken up into two forms; state anxiety and trait anxiety. Once the questionnaires were

completed, I began designing the cognitive tasks in Gorilla. The first task I created was a 2 N-back test, which involved creating precise instructions and coded spreadsheets for the stimuli to appear on the screen. An N-back task consists of remembering a sequence of letters and determining whether the letter on the present screen matches the one seen two letters ago. Individuals would be presented with a sequence of 100 letters and would have to press 'Yes' or 'No' for each passing letter. The same task was created again, implementing a 3 N-back test; therefore, the participants would have to remember the letters they saw three letters back. The N-back test measures working memory capacity; cognitive load is increased when participants have to hold more items in memory while paying attention to the current item flashing in front of them. Finally, I designed a second cognitive task, which consisted of a dual-task to again, increase cognitive load. The task comprised of a Corsi block test and a simple digit span test, where a single digit is presented. This digit would then have to be held in the individual's working memory while they observed and replicated a block pattern consisting of nine blocks lighting up in a specific sequence. Once all the components were completed, the separate parts (questionnaires and tasks) were connected into one continuous experiment using Gorilla's experiment tree. The final design layout consisted of a thorough explanation of the study, a consent form, and all questionnaires in succession, followed by the 2 N-back, 3 N-back, and the dual Corsi block task (breaks and perceived efforts scales were inserted throughout the study). Overall, the study will take approximately 25-30 minutes to complete in one continuous session online.

Future directions

With this research, I plan to recruit and test participants using the experimental design I created on Gorilla. I hope to analyze the data collected in the coming months, which will

further my thesis in the honour's psychology program.

This research can also help researchers and clinicians differentiate between cognitive performance influenced by anxiety and performance that is influenced by the average cognitive decline. With this distinction, better inferences can be made during cognitive evaluations to understand where the working memory decline originates. Thus, this research has the ability to be used as a baseline to start looking into whether the presence of anxiety and cognitive decline could be potential indicators/predictors of disease.

Overall, this program was a meaningful and valuable experience, which led me to expand my knowledge and skillset surrounding researched-based experiment building and write a literature review effectively. I am very fortunate to have been a part of this program since many students do not get involved in designing and coding an experiment. I now have first-hand experience on how to start and finish a research design accurately. I feel that this experience has given me the confidence and tools to be successful in my future academic goals, such as succeeding in my honours program and applying to graduate school.

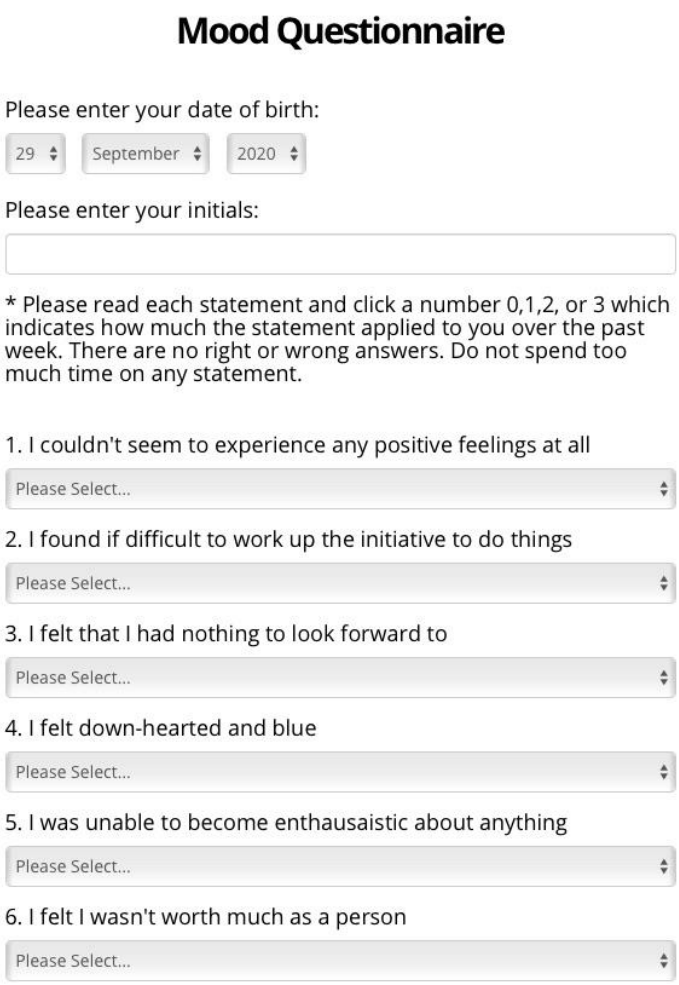

Figure 1.1. A portion of The Depression Anxiety Stress Scale (DASS) used in the experiment on Gorilla.

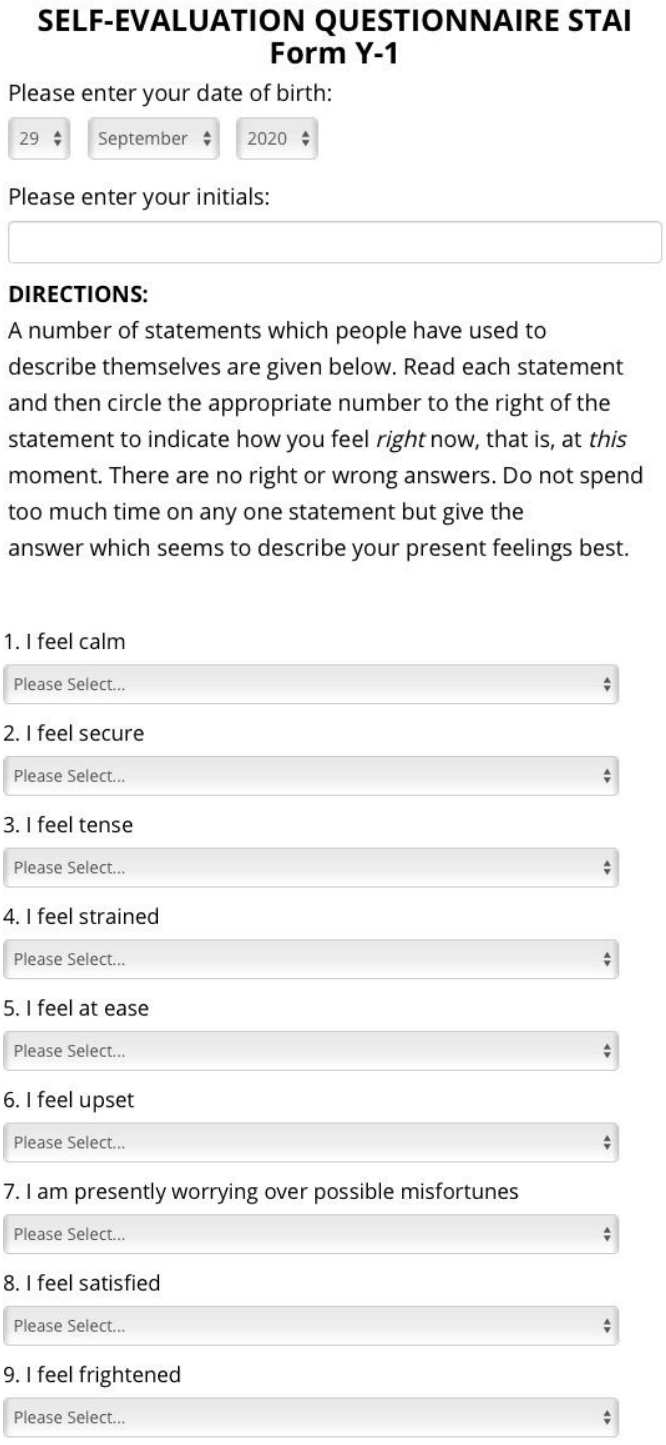

Figure 1.2. A portion of the State Trait Anxiety Inventory (STAI) used in the experiment on Gorilla.

```
var _keyboardDisplay = 'Digit Task Recall';
var _keyboardScreenIndex = 0;
var _keyboardKeysColumn = 'Keys';
var _keyboardKeysSeparatorColumn = 'KeySeparator';
var _enableBackspace = true;

gorillaTaskBuilder.onScreenStart((spreadsheet: any, rowIndex: number, screenIndex: number, row: any, container: string) => {
    if(row.display == _keyboardDisplay && screenIndex == _keyboardScreenIndex) {
        var inputElem = $(container).find('.gorilla-content-response-text input');
        var inputFrame = $(inputElem).parents('.gorilla-zone');

        // first, hide the input element
        $(inputElem).hide();

        // next, populate the frame with our keyboard and display
        $(inputFrame).append('<div class="fullwidth gorilla-float centered"><div class="keyboard-display" style="font-size:36px; height:40px;"></div><
        var displayFrame = $(inputFrame).find('.keyboard-display');
        var keysFrame = $(inputFrame).find('.keyboard-keys');

        var keysStr = row[_keyboardKeysColumn];
        var keysSep = row[_keyboardKeysSeparatorColumn];

        var keysSplit = keysStr.split(keysSep);
        var keys: { label: string, value: string }[] = [];
        for(var i=0; i<keysSplit.length; i++) {
            var k = keysSplit[i].trim();
            if(k.length) {
```

Figure 1.3. A portion of the coded script used to design the Corsi Block/Digit Span task on Gorilla.

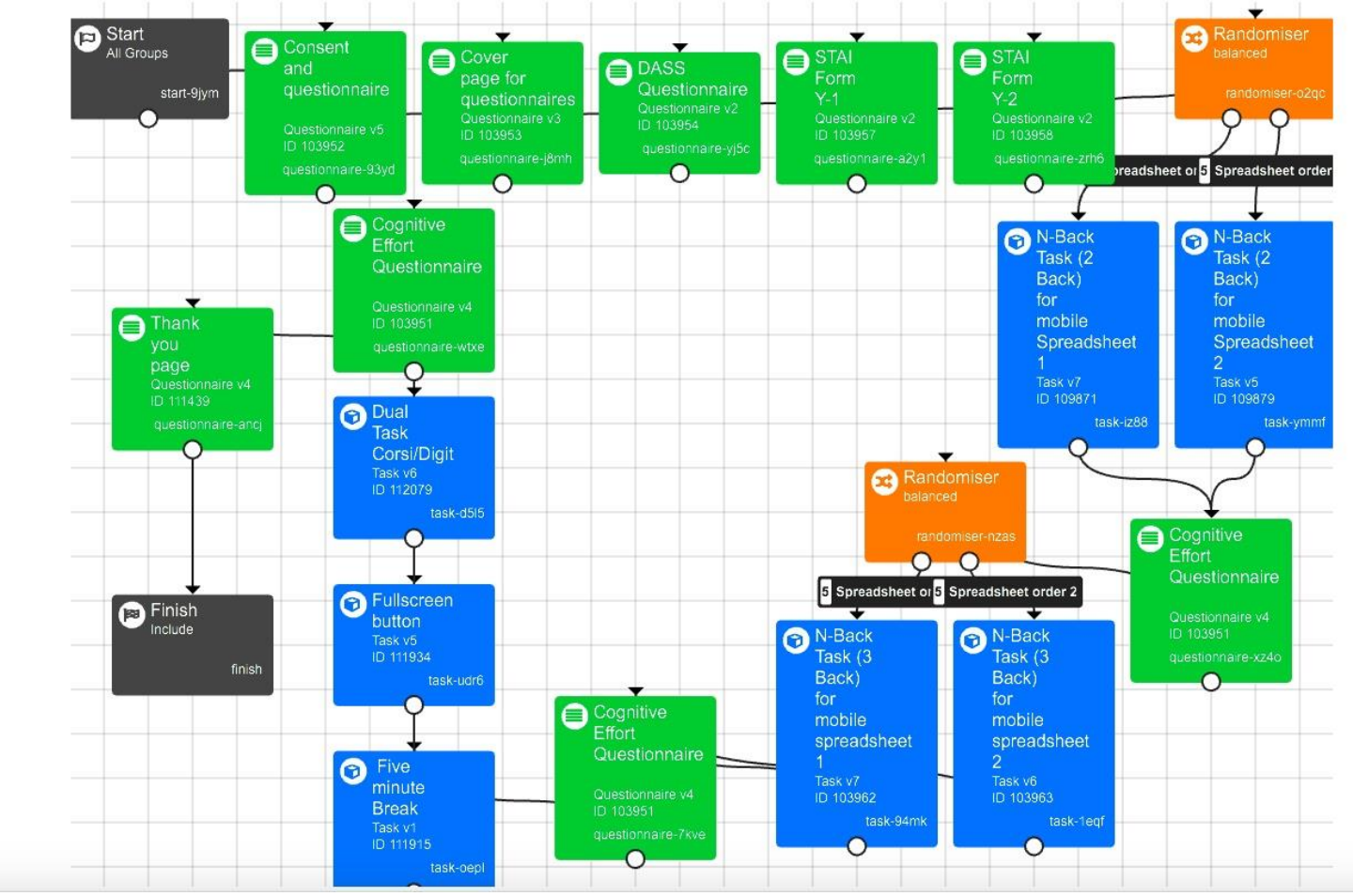

Figure 1.4. The experimental design tree in Gorilla.

References

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